Rev. Colomb. Nefrol. 2017;4(2): 159 - 167 http://www.revistanefrologia.org

Original Research

doi: http://dx.doi.org/10.22265/acnef.4.2.277

Glomerular filtration in a university community in Armenia, Colombia

Filtración glomerular en una comunidad universitaria en Armenia, Colombia

Olga Alicia Nieto Cárdenas[1,*], Jhon Serna Flórez[2]

[1]MD, MPH, PhD, Teacher of Medicine Program, Public Health Group, Faculty of Health Sciences, University of Quindío, Armenia, Colombia

[2] MD, Internist, Nephrologist, Epidemiologist, Teacher of Medicine Program, Faculty of Health Sciences, University of Quindío, Armenia, Colombia

Abstract

Objective: To identify glomerular filtration with six equations in a university community in Armenia, Colombia.

Methods: A cross - sectional descriptive study was carried out in a university community: students and administrators, which included 172 participants. The glomerular filtration rate (GFR) was calculated by 6 equations, Cockcroft-Gault, Cockcroft-Gault adjusted for body surface, CKP-EPI, MDRD for white and black race. The differences between the groups were calculated using analysis of variance or chi-square for the categorical variables. The explained variation (R2) was calculated for each of the equations with a multiple regression.

Results: Mean GFR was found at 84 mL/min/1,73 m2 with the Cockcroft-Gault, body surface adjusted Cockcroft-Gault and Black Race MDRD equations, with significant differences by group ($p \leq 0.01$), in Students above 91 mL/min/1,73 m2 and in the administrative group above 75 mL/min/1,73 m2.

Glomerular filtration presents an explained variation (R2) greater than 85,76 % with the Cockcroft-Gault equation adjusted for body surface area, with a statistically significant difference ($p \leq 0.01$).

Conclusions: In the present study, it was found that renal function, measured through the glomerular filtration rate, was normal in students and with slight decrease in the administrative group.

The GFR was similar with the Cockcroft-Gault, Body Surface Adjusted Cockcroft-Gault and MDRD Black Race equations. It is recommended the Cockcroft-Gault equation adjusted for body surface that presents the largest variation explained with the study variables for this population.

Key words: Chronic renal disease, glomerular filtration rate.

doi: http://dx.doi.org/10.22265/acnef.4.2.277

Resumen

Objetivo: identificar la filtración glomerular con seis ecuaciones en una comunidad universitaria de Armenia, Colombia.

Métodos: se realizó un estudio descriptivo de corte transversal en una comunidad universitaria, estudiantes y administrativos, que incluyó 172 participantes. Se calculó la tasa de filtración glomerular (TFG) mediante seis ecuaciones, Cockcroft-Gault, Cockcroft-Gault ajustado por superficie corporal, CKP-EPI, MDRD para blancos y negros; y se comparó entre los grupos. Las diferencias entre los grupos se calcularon con análisis de varianza o de chi cuadrado para las variables categóricas. Se calculó la variación explicada (R2) para cada una de las ecuaciones con una regresión múltiple.

Resultados: se encontró una TFG promedio en 84 mL/min/1,73 m2 con las ecuaciones de Cockcroft-Gault, Cockcroft-Gault ajustado por superficie corporal y MDRD para raza negra, con diferencias significativas por grupo ($p \leq 0,01$): en el grupo de estudiantes por encima de 91 mL/min/1,73 m2 y, en el grupo de administrativos, por encima de 75 mL/min/1,73 m2.

La filtración glomerular presenta una variación explicada (R2) mayor del 85,76 % con la ecuación Cockcroft-Gault ajustado por superficie corporal, con una diferencia estadísticamente significativa ($p \leq 0,01$).

Conclusiones: en el presente estudio se encontró que la función renal, medida por la tasa de filtración glomerular, fue normal en el grupo de estudiantes y con disminución leve en el grupo de administrativos.

La TFG fue similar con las ecuaciones de Cockcroft-Gault, Cockcroft-Gault ajustado por superficie corporal y MDRD para raza negra. Se recomienda la ecuación de Cockcroft-Gault ajustado por superficie corporal, que presenta la mayor variación explicada con las variables del estudio.

Palabras clave: enfermedad renal crónica, tasa de filtración glomerular.

doi: http://dx.doi.org/10.22265/acnef.4.2.277

Reference this article:Nieto Cárdenas OA, Serna Flórez J. Glomerular filtration in a university community in Armenia, Colombia.Colombian Journal of Nephrology 2017;4(2): 159-167 doi: http://dx.doi.org/10.22265/acnef.4.2.277

Mail: *Olga Alicia Nieto Cárdenas, olgalicianieto@gmail.com

Received:14-05-17 * Accepted: 30-07-17 * Published online: 04-08-17

Introduction

There are several indicators that allow us to approach the assessment of renal function and its impact on people's health. One of these indicators is the glomerular filtration rate, used to identify if there is kidney disease. Chronic kidney disease (CKD) is an important public health problem, both due to its high incidence and prevalence, as well as its high morbidity and mortality and socioeconomic cost[1].

For all this, the early detection of people with hidden CKD is a goal of prevention in many countries. For example, the SEN (Spanish Society of Nephrology) recommends detecting the presence of CKD in all people over 60 years old, either with high blood pressure, or with diabetes, or with cardiovascular disease. Screening consists of evaluating Glomerular Filtering (GF) and albuminuria at least once a year[2].

The consensus document on the management of CKD considers that the estimation of glomerular filtration is the best index to evaluate renal function[3].

In the present study, the recommendations of the National Kidney Foundation (NKF) were taken into account, according to the classification established by K/ DOQI (Kidney Disease Outcomes Quality Initiative). This classification has allowed unifying the criteria for the definition of CKD4, as abnormalities in the structure or renal function present for more than three months and with implications for health. In addition, it has allowed the characterization of CKD according to its etiology, category and glomerular filtration rate and albuminuria. According to these guidelines, CKD is defined, then, as the persistent decrease in renal function, for at least three months, expressed by altered GFR <60 Ml/min/1.73 m^2 and/or presence of kidney damage with histological alterations in renal biopsy. Indirectly, it is defined by markers such as albuminuria, alterations in urinary sediment, and alterations in imaging tests or history of kidney transplantation[4].

The combination of diagnostic criteria is the basis for the classification of CKD in five stages, according to the guidelines of the K/DOQI 2002 of the National Kidney Foundation:

Stage 1: kidney injury with normal or increased glomerular filtration. Glomerular filtration ≥ 90.

Stage 2: kidney injury with mild decrease in glomerular filtration rate. Glomerular filtration 60-89.

Stage 3: moderate decrease in glomerular filtration rate. Glomerular filtration 30-59.

Stage 4: severe decrease in glomerular filtration rate. Glomerular filtration 15-29.

Stage 5: renal failure or dialysis. Glomerular filtration <15.

In the world, in Colombia and in Quindío, kidney disease has increased in recent years and constitutes a significant burden of high-cost disease[1]. It is necessary, therefore, to think not only about its treatment, but also about its detection and early prevention. For this reason, the present study in a university population contributes to the identification of renal function in students and administrators without kidney disease, by using the different equations.

Methods

A descriptive cross-sectional study was conducted to identify the glomerular filtration rate with the different equations and related factors in a university community of Armenia, Colombia.

Population and Sample

Participants 172 people from a public university in the city of Armenia, Colombia, between students and administrators. The sample was obtained in a random manner in the database provided by the Planning Office. The main selection criterion was voluntary: the people who signed the informed consent were included.

Collection of information

The information was collected by the researchers in the primary source, with an instrument designed for this purpose with all the variables of the study, during 2015. Participants were given a clinical history that included socio-demographic variables (age, sex, state civil, educational level). Anthropometric variables were measured, such as weight, height, body mass index (BMI) and abdominal perimeter. In the blood sample, laboratory variables were measured, such as: HDL cholesterol values (mg/dL), total cholesterol (mg/dL), triglycerides (mg/dL), LDL cholesterol (mg/dL), glycemia (mg/dL), creatinine, albumin, globulin, total proteins. In addition, related factors, such as: diseases, medication consumption, exercise and smoking.

Processing and analysis of information

The information was systematized in Excel®; the glomerular filtration rate was calculated with six equations, through the free access calculators offered by the Spanish Society of Nephrology. It was analyzed in the Statgraphics centurion® software. A descriptive analysis was carried out and the average, standard deviation and confidence intervals were calculated, with a comparative analysis by sex. The differences between the groups were calculated with analysis of variance or a chi-squared test to analyze the categorical variables. A value of significance of 5% was considered and the variation explained for each of the equations with a multiple regression was calculated.

Bioethical aspects

In all cases, the ethical principles of the Declaration of Helsinki, 1964, with its amendments up to 2008[5], and Resolution 8430 of 1993 of the Ministry of Social Protection of Colombia6 were complied with[6].

This project was approved by the Institutional Bioethics Committee of the University of Quindío, in Minute No. 50 of 2013[7]. All procedures and controls in the patients and were made after the signing of the informed consent.

Results

Population and Sample

To identify the renal function in the people of the university community, the informed consent was signed by 172 people (85 administrative and 87 students).

The description of the variables with the information is shown separately by quantitative and qualitative variables, by group and by sex, with mean ± standard deviation IC 95% and p. value. They are also described by groups of related variables.

As can be seen in table 1, the average age was 32.42 years; 21.34 years in students and 43.8 years in administrative. The body mass index, of 24.90 on average, was normal in students (23.35) and overweight in administrative (26.38). The average abdominal perimeter (82.81cm) was found within normal limits, on average it was 78.00 cm in students and 87.51 cm in administrative. The average blood

pressure was 111/74 mmg Hg; mean systolic blood pressure was 106.97 mmHg in students and 114.94 mmHg in administrative. Finally, the diastolic pressure was 72.93 mmHg and 75.12 mmHg, respectively.

The lipid profile was found within normal limits, except for the HDL that were found below the recommended limits, without significant differences. The glycemia was found in normal limits (82.52 mg/dL on average): 89.56 in administrative and 83.56 in students, with a p-value of <0.001. The creatinine, finally, was in average values within the normal limits (1.06 mg/dL), with significant differences: 1.03 mg/dL in students and 1.09 mg/dL in administrative, with a value of p <0.001.

When comparing the variables between the participating groups of the university community (students and administrators), significant differences were found (p-value <0.001) in the following variables: age, body mass index, blood pressure, waist circumference, albumin, globulins, total proteins, total cholesterol, LDL cholesterol, triglycerides, glucose and creatinine (table 1).

63% of the participants were women and 37% men. 5% of the participants smoke and 35% do physical exercise, without significant differences between the groups.

The identification of the glomerular filtration rate (GFR), with the six equations, can be seen in table

Table 1.
Quantitative variables by groups (average, standard deviation, 95% CI, p value).

Variables	Average ± Standard deviation	95% CI n = 172	Administrative n = 85	Student n = 87	Anova (p-value)
Age (years)	32,42 ± 13,31	30,46 – 34,38	43,88 ± 9,60	21,34±2,92	< 0,001
BMI (kg/m2)	24,90 ± 3,93	24,32 – 25,49	26,38 ±3 ,72	23,35 ± 3,56	< 0,001
Systolic pressure (mmhg)	110,89 ± 11,54	109,13 – 112,66	114,94 ± 11,51	106,97 ± 10,05	< 0,001
Diastolic pressure (mmhg)	73,95 ± 9,06	72,56 – 75,34	75,12 ± 8,81	72,93 ± 9,14	0,011
Waist circumference (cm)	82,81 ± 11,88	81,05 – 84,58	87,51 ± 11,40	78,00 ± 10,29	< 0,001
Total proteins (mg/dl)	7,13 ± 0,44	7,06 – 7,20	7,22 ± 0,49	7,05 ± 0,37	0,012
Albumin (mg/dl)	4,64 ± 0,30	4,59 – 4,68	4,50 ± 0,28	4,77 ± 0,27	< 0,001
Globulins (mg/dl)	2,49 ± 0,48	2,41 – 2,56	2,71 ± 0,48	2,27 ± 0,37	<0,001
Total cholesterol (mg/dl)	172,96 ± 37,55	167,30 – 178,61	187,42 ± 36,20	158,83 ± 33,40	< 0,001
HDL cholesterol (mg/dl)	42,25 ± 12,10	40,43 – 44,07	41,78 ± 13,53	42,71 ± 10,57	0,613
LDL cholesterol (mg/dl)	104,22 ± 32,27	99,31 – 109,14	112,84 ± 33,15	96,20 ± 29,42	0,007
Triglycerides	138,46 ± 93,10	124,45 – 152,47	177,69 ± 111,49	100,13 ± 45,79	< 0,001
Creatinine	1,06 ± 0,16	1,03 – 1,08	1,09 ± 0,18	1,03 ± 0,14	0,003
(mg/dl)					
Glycemia (mg/dl)	86,52 ± 11,47	84,80 – 88,25	89,56 ± 13,94	83,56 ± 7,34	0,001

2. An average GFR was found at 84 mL/min/1.73 m2 with the Cockcroft-Gault, Cockcroft-Gault equations adjusted by body surface and MDRD for black race, with significant differences by group (value of <0.001): in students, above 91Ml/min/1.73 m2 and in the administrative group, above 75mL/min/1,73 m2. That is, on average, normal glomerular filtration (≥ 90mL/min/1.73 m2) was found for the group of students and with a slight decrease for the group of administrative staff (60-89mL/min/1.73m2).

This would correspond to stage 2 ERC. This was not the case with the CKD-EPI equation for black population, which overestimates glomerular filtration (average 91.79 mL/min/1.73 m2), nor with the MDRD equation for population white, which underestimates glomerular filtration (68.31 mL/min/1.73 m2), as can be seen in Figure 1. It could be observed that the average glomerular filtration presented significant differences by sex with five equations, except Cockcroft-Gault adjusted for body surface, with a slight decrease in glomerular filtration rate (60-89 mL/min/1.73 m2), since it was greater for men than for women.

In Table 3, we can observe the explained variation (R2) and the absolute error (Absolute E) of each of the adjusted models, by means of a multiple regression, to identify the relationship of the variables with the glomerular filtration. It was found that, in the model, glomerular filtration has an explained variation (R2) greater than 85.76% and that they have a statistically significant relationship with the Cockcroft-Gault equation adjusted for body surface area (p value <0.001) in creatinine, age, abdominal perimeter and albumin. Likewise, it presents the smallest absolute error and the other equations have less explained variation. It is also observed that the glomerular filtration decreases, with the increase of creatinine and with age, and increases with the increase of the abdominal perimeter.

Discussion

In the present study it was found that renal function, measured by the glomerular filtration rate, was normal in the students and with a slight decrease

Table 2.
Glomerular filtration rate with 6 equations per group (average, standard deviation, 95% CI, Anova)

Glomerular filtration rate	Average ± Standard deviation	IC95 % n=172	Administrative n = 85	student n = 87	Anova (P)
Cockcroft-Gault	84,89 ± 19,14	83,24 – 86,53	77,87 ± 17,3	91,75 ± 18,43	< 0,001
Cockcroft-Gault corrected by body surface	84,82 ± 15,01	83,17 – 86,46	76,05 ± 13,002	93,39 ± 11,51	< 0,001
White CKD-EPI (Chronic Kidney Disease Epidemiology Collaboration)	79,21 ± 14,54	77,57 – 80,86	69,69 ± 10,93	88,52 ± 11,25	< 0,001
CKD-EPI Negros (Chronic Kidney Disease Epidemiology Collaboration)	91,79 ± 16,84	90,15 – 93,44	80,78 ± 12,67	102,56 ± 13,04	< 0,001
White MDRD (Modification of Diet in Renal Disease).	69,95 ± 12,21	68,31 – 71,60	62,08 ± 9,03	77,64 ± 9,78	< 0,001
Black MDRD (Modification of Diet in Renal Disease).	84,65 ± 14,77	83,00 – 86,29	75,12 ± 10,92	93,95 ± 11,84	< 0,001

in the administrative group. The slight decrease in GFR in the administrative group is explained by age and higher creatinine values than in the group of students.

CKD is a public health problem that affects one in ten adults in the world. According to the global burden study of the disease, in 2010, there were 979,409 people in Colombia with chronic kidney disease; the prevalence in this pathology was 2 per 100 inhabitants and was more frequent in females[8]. By 2015, the prevalence of CKD was 66.8 per 100,000 inhabitants and was higher in men (78.4 x 100,000 habs.), than in women (57.3 x 100,000 habs.). It was also 82.2 x 100,000 inhabitants, in the department of Quindío[9]. According to information from the NHANES (National Health and Nutrition Examination Survey), on the estimated GFR with the CKD-EPI equation, the overall prevalence of stages three to four in CKD increased from 4.8%,

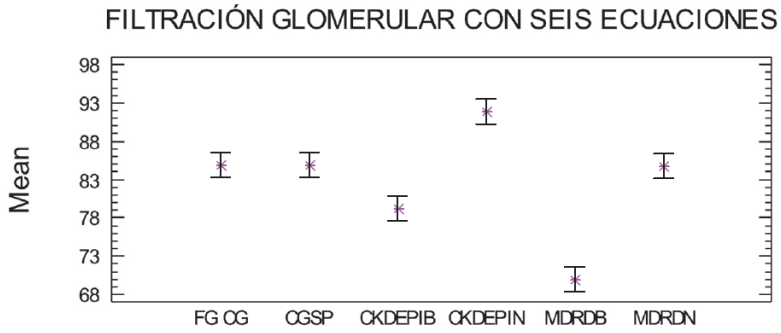

Figure 1. Glomerular filtration with six equations.s.

Table 3
Factors related to the glomerular filtration rate, with the different measurement equations, measured through a multiple regression.

Variable	Cockcroft-Gault	Crockcof Gault /SC	CKD/EPI White	CKD/EPI Blacks	White MDRD	MDRD Blacks
R2	77,03	85,76	73,02	73,07	67,32	67,32
E absolute	7,02	4,27	6,14	7,10	5,62	6,80
Albumin (mg/dL)	p=0,208	p=0,000	p=0,056	p=0,000	p=0,000	p=0,000
Abdominal perimeter (cm)	p=0,000	p=0,017	p=0,001	p=0,000	p=0,001	p=0,001
HDL cholesterol (mg /dL)	p=0,524	p=0,156	p=0,499	p=0,117	p=0,110	p=0,110
Total cholesterol (mg/dL)	p=0,018	p=0,000	p=0,127	p=0,005	p=0,015	p=0,014
Creatinine (mg/dL)	p=0,000	p=0,000	p=0,000	p=0,000	p=0,000	p=0,000
Age (years)	p=0,000	p=0,000	p=0,000	p=0,000	p=0,000	p=0,000
Glycemia (mg/dL)	p=0,745	p=0,727	p=0,412	p=0,601	p=0,564	p=0,568
Triglycerides (mg/dL)	p=0,563	p=0,956	p=0,104	p=0,103	p=0,106	p=0,105

in 1988, to 6 , 9%, in 1994, and remained stable afterwards, with a prevalence of 6.9% between 2011 and 2012[10].

Although this cross-sectional study was carried out in a limited population, on a university campus without previous knowledge of kidney disease, it contributes to the knowledge of renal function based on glomerular filtration and is compared with other studies of the context National and international.

The TFG was similar with the Cockcroft-Gault equations, Cockcroft-Gault adjusted for body surface and MDRD for black race. The CKD-EPI equation for black population overestimates glomerular filtration and the MDRD equation for white population underestimates glomerular filtration.

It is important to note in mind that the population studied is mestizo, without identified kidney disease and without predominance of blacks or Caucasians.

In the city of Medellín, Colombia, it was found that, in patients with CKD, "the median glomerular filtration rate (GFR) was related to stage 3 CKD (50.2 ± 18.6), which was the more frequently, and a significantly different trend was observed, with a higher proportion of patients in advanced stages for the group of 65 and over"[11].

In Colombia, no studies comparing the different equations in the general population have been found, which is why frequent studies such as the consensus document in Spain[3] are taken as reference standards, which recommends: "according to the majority of scientific societies, We recommend the use of the MDRD-4 or MDRD-IDMS equation depending on whether the method for measuring creatinine has traceability or not". It also shows that: "The MDRD equation has been obtained from individuals with a certain degree of renal failure". On other occasions, studies are taken as a reference for the Anglo-Saxon population, which recommend the use of the CKD-EPI equation, because "the CKD-EPI equation is better than the MDRD equation"[12]. For its part, a study conducted in Argentina, when comparing the two equations, highlights that "therefore, the new CKD-EPI equation decreases the number of patients with GFR below 60 ml/min/1.73 m2 and assigns stages of IFG higher to a greater number of patients"[13]. The latter coincides with the results of the present study, with regard to CKD-EPI for the black population.

Likewise, it was found that, in the model, glomerular filtration presents an explained variation (R2) greater than 85.76% and has a statistically significant relationship with the Cockcroft-Gault equation adjusted by body surface. For all the above, this is the equation that should be considered for the calculation of GFR in this population.

Conclusions

In the present study it was found that renal function, measured by the glomerular filtration rate, was normal in the students and with a slight decrease in the administrative group. The GFR was similar with the Cockcroft-Gault, Cockcroft-Gault equations adjusted for body surface and MDRD for black race.

The glomerular filtration rate increases with the abdominal perimeter and decreases with the increase in creatinine and age.

The measurement of GFR with the Cockcroft-Gault equation adjusted by body surface in this population without identified CKD is recommended, because it was found that, in the model, the variation explained is greater and the

error is smaller, compared with the other equations. Likewise, CKD-EPI Glomerular filtration in a university community in Armenia, Colombia for black population overestimates the GFR and MDRD for white population; it values it below the rest.

Conflict of interests

The authors declare no current or potential conflict of interest.

Acknowledgments

We express our gratitude to the people who participated in this research, to the Center of Health of the University and to the Vice-Rectory of Investigations of the University of Quindío, for their support in this project. Finally, we thank the SEN for the contribution of the calculator with the six open access equations.

Ethical responsibilities

Protection of people and animals

The authors declare that no experiments have been conducted on humans or animals for this research.

Confidentiality of the data

The authors declare that patient data does not appear in this article.

Right to privacy and informed consent

The authors declare that patient data does not appear in this article.

Referencias

1. Situación de la enfermedad renal crónica en Colombia 2009. Resolución 4700 de 2008. Fondo Colombiano de Enfermedades de Alto Costo. Bogotá, diciembre 2010.
2. Alcázar R, De Francisco ALM. Acción estratégica de la SEN frente a la enfermedad renal. Nefrología. 2006;26(1):1-4.
3. García G, Montañés Bermúdez R, Bover Sanjuan J, Cases Amenos A, Deulofeu A, De Francisco ALM et al. Sociedad Española de Bioquímica Clínica y Patología Molecular (SECQ), Sociedad Española de Nefrología (SEN). Documento de consenso: Recomendaciones sobre la utilización de ecuaciones para la estimación del filtrado glomerular en adultos. Quím Clín 2006;25(5):423-30.
4. National Kidney Foundation: K/DOQI Clinical Practice Guidelines for Chronic Kidney Disease: Evaluation, Classification and Stratification. Am J. Kidney Dis. 2002;39(Suppl 1):S1-S266.
5. Asociación Médica Mundial. Declaración de Helsinki. Principios éticos para las investigaciones médicas en seres humanos. Finlandia 1964. Seúl. 2008.
6. Ministerio de Salud de Colombia. Resolución 8439 de 1993. Por la cual se establecen las normas científicas, técnicas y administrativas para la investigación en salud. Bogotá. 1993.
7. Universidad del Quindío. Comité de Bioética. Acta No. 50 de 2013. Armenia. 2013.
8. Situación de la enfermedad renal crónica, hipertensión arterial y diabetes mellitus en Colombia 2015. Fondo colombiano de enfermedades de alto costo. Bogotá. 2015.
9. Análisis de situación de salud (ASIS) Colombia, 2016. Ministerio de Salud. Bogotá, Colombia. 2016.

10. Murphy D, McCulloch CE, Lin F, Banerjee T, Bragg-Gresham JL, Eberhardt MSet al. Trends in prevalence of chronic kidney disease in the United States. Ann Intern Med. 2016;165(7):473. Disponible en: https://doi.org/10.7326/M16-0273
11. Yepes Delgado CE, Montoya Jaramillo M, Orrego Orozco BE, Cuellar Santaella MH, Yepes Núñez JJ, López Muñoz JP et al. Calidad de vida en pacientes con enfermedad renal crónica sin diálisis ni trasplante de una muestra aleatoria de dos aseguradoras en salud. Medellín, Colombia, 2008. Nefrología. 2009;29(6):548-56.
12. Levey AS, Stevens LA, Schmid CH, Zhang YL, Castro AF, Feldman HI et al; CKD-EPI (Chronic Kidney Disease Epidemiology Collaboration). A new equation to estimate glomerular filtration rate. Ann Intern Med. 2009;150(9):604-12. Disponible en: https://doi.org/10.7326/0003-4819-150-9-200905050-00006
13. Rosa-diez GJ, Varela F, Crucelegui S, Algranati SL, Greloni G. Comparación entre las ecuaciones CKD-EPI y MDRD para la estimación del filtrado glomerular en pacientes con enfermedad renal crónica. Medicina (B. Aires). 2011;71(4):323-30.